CLAIMS

1. A piezo-electric transformer circuit (200) incorporating a piezo-electric transformer (10) comprising mutually vibrationally coupled primary and secondary regions (12, 14), the secondary region (14) operable to provide an output signal for use in generating an output from the circuit (200), and vibration exciting means (210, 230, 250, 270) for exciting the transformer (10) into vibration to generate the output signal, characterised in that the transformer (10) comprises a hard piezo-electric material having a dielectric loss of substantially 0.005 or less at 1 kHz frequency.

2. A circuit according to Claim 1 wherein the exciting means (210, 230, 250, 270) is operable to excite vibrations at a frequency corresponding to a modal resonance of the primary and secondary regions.

3. A circuit according to Claim 1 or 2 wherein the exciting means incorporates a network (270) operable to phase shift and amplify the output signal to generate a drive signal for exciting and thereby sustaining vibrations within the transformer (10).

4. A circuit according to Claim 3 wherein the network (270) is operable to phase shift the output signal in a range of 30° to 150° to generate the drive signal.

5. A circuit according to Claim 3 wherein the network (270) is operable to phase shift the output signal in a range of 30° to 90° to generate the drive signal.

6. A circuit according to any one of Claims 1 to 5 wherein the exciting means incorporates amplifiers (230, 250) arranged in a bridge configuration operable to drive the transformer (10).

7. A circuit according to any one of Claims 1 to 6 wherein the exciting means (210, 230, 250, 270) incorporates at least one inductor through which the transformer (10) is driven at its

primary region (12), the inductor operable to electrically resonate with a capacitor provided by the primary region (12) at a frequency corresponding to that of the vibrations.

8. A circuit according to Claim 7 wherein said at least one inductor incorporates a ferrite core.

9. A circuit according to any preceding claim incorporating rectifying means (290) for rectifying the output signal from the secondary region to provide the output from the circuit, the output being in the form of a unipolar output potential.

10. A circuit according to Claim 9 wherein the rectifying means(290) incorporates a rectifier diode (D1) operable to provide a conductive path for the output signal to a ground potential to assist with developing the unipolar output potential.

11. A circuit according to any preceding claim wherein the transformer (10) is operable to impart a greater voltage amplitude to the output signal relative to that of the drive signal.

12. A circuit according to any preceding claim wherein the transformer (10) is operable to vibrate in a longitudinal mode of acoustic resonance.

13. A circuit according to any preceding claim wherein the primary region (12) of the transformer (10) comprises a stack of mutually joined piezo-electric material elements (20), each element (20) incorporating electrical connections and arranged to be excited in parallel with other of the elements (20).

14. A circuit according to Claim 13 wherein the transformer (10) incorporates in a range of 2 to 40 elements in the primary region (12) and a single element in the secondary region (14).

15. A method of operating a piezo-electric transformer (10), the method comprising the steps of:

(a) providing the transformer (10) incorporating mutually vibrationally coupled primary (12) and secondary (14) regions, the secondary region (14) providing an output signal from the transformer (10), the transformer (10) being fabricated from a hard piezo-electric material having a dielectric loss of substantially 0.005 or less at 1 kHz; and

(b) establishing a feedback network (210, 230, 250, 270) for processing the output signal to generate a drive signal and applying the drive signal to excite oscillatory vibrations in the primary region (12) which couple to the secondary region (14), thereby generating the output signal in the secondary region and sustaining the vibrations in the transformer.

16. A method according to Claim 15 wherein the vibrations are at a frequency corresponding to a modal resonance of the primary and secondary regions (12, 14).

17. A method according to Claim 15 or 16 wherein the output signal is phase shifted and amplified in the network (210, 230, 250, 270) to generate the drive signal.

18. A method according to Claim 17 wherein the output signal is phase shifted in a range of 30° to 150° in the network (270) to generate the drive signal.

19. A method according to Claim 15, 16, 17 or 18 wherein the transformer (10) is driven from amplifiers (230, 250) arranged in a bridge configuration.

20. A method according to any one of Claims 15 to 19 wherein the transformer (10) is driven at its primary region (12) through at least one inductor arranged to electrically resonate with a capacitor provided by the primary region (12) at a frequency corresponding to that of the vibrations.

21. A method according to Claim 20 wherein said at least one inductor incorporates a ferrite core.

22. A method according to Claim 20 or 21 wherein signals from the secondary region (14) of the transformer (10) are extracted through an inductor arranged to electrically resonate

with a capacitance provided by the secondary region (14) at a frequency corresponding to that of the vibrations.

23. A method according to any one of Claims 15 to 22 wherein the output signal is rectified to provide a unipolar output potential (S2) from the transformer (10).

24. A method according to Claim 23 wherein the output signal is directed through a rectifier diode (D1) to a ground potential, the diode (D1) operative to provide a conductive path to assist with developing the unipolar output potential.

25. A method according to any one of Claims 15 to 24 wherein the transformer (10) is of elongate form operable to vibrate longitudinally along its elongate axis.

26. A method according to any one of Claims 15 to 25 wherein the transformer (10) is operable to impart a greater voltage amplitude to the output signal relative to the drive signal.

27. A method according to one of Claims 15 to 26 wherein the transformer (10) is operable to vibrate in a longitudinal mode of mechanical resonance.

28. A method according to any one of Claims 15 to 27 wherein the primary region (12) comprises a stack of mutually joined piezo-electric material elements (20), each element (20) incorporating electrical connections and arranged to be excited by the drive signal in parallel with other of the elements.

29. A method according to Claim 28 wherein the transformer (10) incorporates in a range of 2 to 40 elements in the primary region (12) and a single element in the secondary region (14).

30. A personnel-wearable sensing apparatus operable according to a method claimed in any one or more of Claims 15 to 19 for generating an elevated bias potential for use in the apparatus.

31. A piezo-electric transformer (10) comprising mutually vibrationally coupled primary (12) and secondary regions (14), the primary region (12) incorporating a stack of piezo-electric material elements (20), each element (20) incorporating electrical connections for connecting a drive signal thereto and the secondary region (14) incorporating electrical connections for extracting an output signal therefrom, characterised in that the transformer (10) comprises a piezo-electric material having a dielectric loss of substantially 0.005 or less at 1 kHz.

32. A transformer according to Claim 30 or 31 wherein the transformer (10) incorporates in a range of 2 to 40 elements in the primary region (12), and a single element in the secondary region (14).

33. A personnel-wearable sensing apparatus incorporating a transformer (10) according to any one of Claims 31 to 32, the transformer (10) operable to generate a bias potential for use in the apparatus.